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Coupling softening — ultrafiltration like pretreatment of sea water case study of the Corso plant desalination (Algiers)

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Abstract

The demand of fresh water is increasing twice as fast as population growth, while the natural resources remain invariable or in reduction. Otherwise, the needs of development make that the demand will be superior to resources. To satisfy these last, new techniques of drinking water production implementation by using the desalination of sea water by reverse osmosis. We have the results relating to the pretreatment of the sea water plant desalination by reverse osmosis located in (Corso) the east of Algiers at the Mediterranean sea side. With an aim of increasing the efficiency and the lifespan of reverse osmosis plant in order to avoid or to minimize, the scaling and the membranes fouling, the water pretreatment sea is necessary. The sea characteristics water are: total hardness (390°F), conductivity (55,000 μs/cm), turbidity (8.40 NTU). Like technique of pretreatment, we chose the water softening of sea by lime, the resin and ultrafiltration, and finally coupling ions exchange — ultrafiltration and coupling precipitation by lime-ultrafiltration. Three resins amberlite CG 50, CG 400, IR 120 were used. The ultrafitration tests have been made on tubular mineral membrane CARBOSEP M2 (15 kg/mol). The coupling treatment of the filtrate by ions exchange (amberlite IR 120) to ultrafiltration gave the best result with 98% of turbidity reduction, a final value of 0.13 NTU. An improvement of the limit permeate flux was obtained, where the value passed from 30.6 L/h m^2 (ultrafiltration alone) to a value of 47.5 L/h m^2 for a concentration of 360 mg/L of the resin amberlite IR 120 with an increase of 35%.

Keywords: Reverse osmosis; Ultrafiltration; Pretreatment; Seawater

1. Introduction

Algeria, from its development program and its vast arid and semi arid, is directly confronted with the problems of the fresh water availability, at the same time for consumption of drinking water, agriculture, industry. The water research of good quality proves to be essential for the survival of the alive beings on ground. To face this announced water shortage, new techniques of drinking water production very powerful thus could be applied to satisfy the needs for the

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increasing population. One of the promising techniques for certain countries is the sea water desalination. To preserve the efficiency and the lifespan of reverse osmosis installation, a water pretreatment is necessary. This last will make it possible to avoid or minimize the scaling and the membranes fouling. Former studies were undertaken. Zhang et al. [1] tested the potential of ultrafiltration prior to reverse osmosis for high turbidity seawater. Brehant et al. [2] allowed the reduction of the membranes fouling of reverse osmosis by using ultrafiltration with SDI values very weak.Wolf et al. [3] showed that ultrafiltration unlike conventional pre-treatment technologies, provides a physical barrier to particulate and colloidal material and ensures that RO plants can operate on a continuous basis, at high and stable fluxes, at higher recovery rates. Halpern et al. [4] showed that the use of ultrafitration membranes is now being considered as a viable solution for pretreatment to seawater reverse osmosis plants. Ultrafitration membranes can provide product water with consistently low turbidity, regardless of seawater quality. Teng et al. [5] used the various methods of pretreatment by using ultrafiltration and microfiltration. Test results showed that membrane pretreatment consistently reduced filtrate of good quality.

This work aims to examine the possibility of finding a pretreatment adequate with sea water of Corso desalination plant by the coupling softening ultrafiltration. for this purpose, we considered the elimination of the water hardness by ions exchange and decarbonatation to lime by determining the optimum conditions for softening by precipitation. Ultrafiltration test on raw water were done and proceed to the coupling softening-ultrafiltration.

2. Experimental conditions

2.1. Description of the station

The Corso desalination plant of sea water located at 35 km of the Algiers east localised along the coastal tape of the Mediterranean sea with total capacity of 5000 m^3/J with a conversion rate equal to 40%. The current pretreatment comprises a coagulation, decantation followed by filtration.

2.2. Characteristics of raw water

The following table gives the principal characteristics of the Corso plant sea water followed bacteriological analyses. The physico-chemical analyses make it possible to control the water composition and its quality in reference to the potability standards.

We notice that the total hardness is very high 390°F. It is a significant step for the systems design of pretreatment and the reverse osmosis system, in order to determine the type and the pretreatment size.

The bacteriological analyses indicate the absence of indicator germs of fecal pollution, one

Table 1
Characteristics of raw water

Parameters	Mean value	Algerian potability standards
Turbidity, NTU	8.40	5
Total hardness, °F	390	50
TAC, °F	11.66	35
TDS, mg/L	58,000	500
Ca^{2+}, mg/L	449	200
Mg^{2+}, mg/L	1387	150
Na^{+}, mg/L	12,179	250
K^{+}, mg/L	418	12
Cl^{-}, mg/L	21,555	600
SO_4^{2-}, mg/L	3200	250
HCO_3^{-}, mg/L	158.6	–
NO_3^{-}, mg/L	0	50
Conductivity, μs/cm	55,000	–
SiO_2, mg/L	0	–
Fe^{2+}, mg/L	<0.01	0.2
pH	8.4	6.5–8.5
Temperature, °C	18–22	30